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J. Michael Neary — March 25 2004

J. Michael Neary — Date

Inventor:	Detore and Kyono	)
		)Group Art Unit: 3682
Serial No.:	10/035,513	)
		)Examiner: Vicky A. Johnson
Filed:	Oct. 19, 2001	)
		)
Title:	"Hybrid Composite Flywheel Rim and Its Manufacturing Method"	

Brief on Appeal

March 25, 2004

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Sir:

This Brief on Appeal is being submitted in furtherance of Applicant's appeal from the final rejection of claims 1 and 5-7 in the Final Office Action dated October 31, 2003.

1) Real party in interest

Toray Composites, America, Inc., assignee of this Application, is the real party in interest.

2) Related Appeals and Interferences

Applicant knows of no related interferences or appeals that would directly affect or be directly affected by or have a bearing on the Board's decision in this pending appeal.

3) Status of Claims

Claims 1 and 5-7 were rejected in the Final Office Action as noted in summary fashion below. No claims have been allowed.

A. Claims 1, 5 and 7 have been rejected under 35 USC 112, 2nd ¶, as indefinite because of the phrase "a thermosetting resin such as epoxy resin". The Examiner regards this phrase as indefinite "because it is unclear whether the limitations following the ['such as'] phrase are part of the claimed invention."

B. Claims 1, 5 and 7 have been rejected under 35 USC 102 as anticipated by P/N 6,299,718 to Kimura.

C. Claim 6 was rejected under 35 USC 103 as unpatentable over Kimure.

4) Status of Amendments

On January 26, 2004 (concurrently with the Notice of Appeal), an amendment after final rejection was submitted under Rule 116. The amendment attempted to delete the "such as epoxy resin" phrase from claims 1 and 5 that the Examiner considers to be objectionable. The amendment also amended claim 1 to add "multiple layers" made of bands of tows. In an Advisory Action dated Feb. 23, 2004, the Examiner refused to enter this amendment because it "raised new issues requiring further consideration and/or search" even though this subject matter is claimed in claim 7 and has been in claim 7 since the filing date.

On March 26, 2004, (concurrently herewith) Applicants filed a Request for Reconsideration of the refusal to admit their R116 amendment, explaining that the added subject matter had already been claimed and searched.

5) Summary of the Invention

The invention provides a composite flywheel rim, and a method of manufacturing a flywheel rim having multiple hybrid fiber layers in each of several radial zones. The fibers are filament wound in bands of tows, with each tow having only a single fiber type. In each of the zones, the mixture ratio of carbon fibers versus glass fibers is constant. Zone by zone, the ratio of carbon to glass fibers incrementally increases toward the outside of the rim by increasing the number of carbon fiber tows and decreasing the number of glass fiber tows.

To achieve uniform stress distribution during rotor spinning, it has been found that macroscopically uniform fiber distribution of carbon fiber amongst the glass fiber tows may be important. The macroscopically uniform distribution can be achieved by controlling the correlation between lead rate of fiber band per mandrel revolution and the winding length. Carbon fiber tow spacing and position in the band, and a width of a carbon fiber tow also affect the lay up pattern, however, the most effective and the easiest way to change the lay up pattern with constant parameters is by controlling the winding length.

6) Issues

A. Whether the rejection of claims 1, 5 and 7 under 35 USC 112, 2nd ¶, as indefinite because of the phrase "a thermosetting resin such as epoxy resin" was proper.

B. Whether the rejection of claims 1, 5 and 7 under 35 USC 102 as anticipated by P/N 6,299,718 to Kimura was proper.

C. Whether the rejection of claim 6 under 35 USC 103 as unpatentable over Kimure 102 was proper.

7) Grouping of Claims

The rejected claims do not stand or fall together; that is, claims 1 and 5-7 are separately patentable, as explained in detail in the following Argument.

8) Argument

For simplicity of relating the summary Status of the Claims in §3 and the Statement of Issues in §6 with the related argument in this §8, the same letters used in §§3 and 6 will identify the argument sections.

A) Claims 1, 5 and 7 have been rejected under 35 USC 112, 2nd ¶, as indefinite because "the Examiner regards the phrase "a thermosetting resin such as epoxy resin"to be indefinite "because it is unclear whether the limitations following the ['such as'] phrase are part of the claimed invention."

Claim 1 calls for a hybrid composite flywheel rim having a cylindrical fiber-wound structure having at least two different types of fibers, including a first fiber type and a second fiber type, impregnated with a thermosetting resin **such as epoxy resin**, and wound in an annulus on a mandrel, said two different fibers having different elastic moduli; [underlining added to indicated the words in issue]

the fiber is distributed in the cylindrical fiber-wound structure as *multiple layers* made of bands of tows, each tow having only a single type of fiber. The tows lie in *said layers in* a lay-up pattern that is defined by the correlation between lead rate per mandrel revolution and winding length to produce a random distribution of the first fiber type amongst the second fiber type macroscopically *radially from layer to layer.* (Italicized words were added in a Rule 116 amendment that was not entered)

The heart of the §112 rejection of claims 1 and 5 (and claim 6, dependant on claim 5) is that "the phrase 'such as' renders the claim indefinite because it is unclear whether the limitations following the phrase are part of the claimed invention".

Applicants believe that "such as" in the phrase "a thermosetting resin such as epoxy resin" in these claims does not make it difficult for a person of ordinary skill in the art to avoid the claim literal scope of the claim. In fact, the "such as" phrase in this context contributes to clarity and precision because it gives an example of the more general term "thermosetting resin", giving guidance to the person reading the claim as to the correct interpretation of the general term. The reader can then go the

specification and find the exact language from the claim to confirm the clear meaning of the claim. This is in the penultimate paragraph on page 7, which reads as follows:

> "Wet filament winding, where a thermoset resin such as epoxy is impregnated into raw fibers during the winding operation, is the preferred fabrication method for a composite rim."

Thus, Applicants see no basis for concern that the "such as" phrase in claims 1 and 5 would give rise to doubt about the meaning. Resin impregnation of fibers in fiber winding operations is a well understood process as illustrated in the prior art of record. Applicant believe that the meaning of the phrase "impregnated with a thermosetting resin such as epoxy resin" will be clear and precise in the minds of persons of ordinary skill in the art of filament winding.

Applicants invite the Examiner to set forth in the Examiner's Answer her reasons why she believes that this phrase would give rise to lack of clarity or precision. It is difficult for Applicants to respond to the rejection without an explanation of how a person of ordinary skill in the art could have doubt as to the meaning of the phrase.

B. Claims 1, 5 and 7 have been rejected under 35 USC 102 as anticipated by Kimura et al (US 6,299,718). Kimura discloses a thick-walled cylindrical structural part of undisclosed use. He refers to a wall thickness of 40mm (1.6"), which is not thick enough to make a flywheel with a significant energy storage capacity. Applicants claim a composite flywheel rim. There is nothing in Kimura to suggest to a person of ordinary skill in the art that it could be used in a flywheel. Kimura is interested in bending strength and bending modulus, two structural features of great importance in structural members such as columns and beams, but of virtually no importance in a flywheel that rotates about its axis. In a flywheel, the centrifugal forces resulting from high-speed rotation translate into hoop strain and resulting radial growth. Hence, the strength and modulus of the fibers in the composite flywheel rim are selected to increase toward the radial outside of the rim to ensure strain matching and avoidance of excessive tensile conditions in the flywheel rim during high-speed operation. These are known design elements in the composite flywheel art and would be paramount in

the mind of a designed of composite flywheels. Kimura's structural member is made of alternating layers of carbon fiber and glass fiber in a resin matrix, with the ratio or carbon fiber layers to glass fiber layers being constant at about 8 or 9:1. A flywheel rim made in this way would delaminate at relatively low speed; it would be useless as a flywheel rim. Thus, the structural member disclosed by Kimura is not a flywheel rim and could not be used as a flywheel rim, and this fact would be well understood by those skilled in the art. Accordingly, Applicants believe that Kimura does not anticipate the invention defined in claim 1, 5 and 7.

The problem that Kimura addressed was entirely different and unrelated to the issues of concern to the designers of flywheels, and if his solution were to be incorporated in a flywheel, it would produce a dangerous and inoperative flywheel rim. The problem Kimura addressed was interlayer separation produced by internal stresses caused by cooling the part from curing temperature to room temperature. His solution was to wind the structural part with multiple zones of windings, each zone having 8 or 9 layers of high modulus carbon fiber and one layer of low modulus glass or aramid fiber. The low modulus fiber provided cushioning to reduce internal stress resulting from cooling to room temperature from curing temperature.

The Examiner asserts that Kimura discloses "an annular structure having a plurality of zones, each with multiple fiber layers in a resin matrix, each said fiber layer having a mixture of carbon fiber tows and glass fiber tows at a ratio of tows that is constant in each layer of any single zone, and said ratio incrementally increases zone-by-zone toward outside zones of said rim." Applicants respectfully disagree that this is a correct description of Kimura. Instead, Applicants assert that Kimura discloses a structural member (not usable as a flywheel rim) that has multiple fiber layers, each layer having only one type of fiber, either carbon fiber for strength, or glass fiber for cushioning. The paragraph cited by the Examiner to support the contention that the fiber types are mixed in each layer does not support the contention. It is clear from a close reading of this paragraph that the glass laminations (layers) are applied at 85°, and the carbon laminations (layers) are applied at 45° and 10°, and there is one glass fiber layer between about every eight carbon fiber layers throughout the entire structural member.

In addition, Kimura does not disclose a structure wherein the two fiber types are distributed randomly amongst each other. Indeed, in Kimura's structural member, the

fiber types are each in discrete layers, not randomly distributed amongst each other as claimed.

Claim 7 calls for "macroscopically uniform distribution in each zone by controlling the correlation between lead rate of the fiber band as it is wound onto the mandrel per mandrel revolution and the winding length." Kimura does not disclose this structure or the problem of unintentionally failing to achieve it and the solution to ensure that the problem does not occur. Applicants have discovered the problem and have identified its cause and have solved it in a way to avoid it reliably. Claim 7 claims the structure by defining, in part, how the structure is arranged during its creation. There is nothing in the Patent Law that forbids Applicants from claiming their invention in this way.

Kimura is entirely silent on the problem that Applicants have identified and solved. Kimura is just as likely to encounter the unintended injurious radial alignment of fiber types as Applicants identified in their application as Applicants encountered, analyzed and solved. There is no disclosure in Kimura whatsoever of the problem or its solution that Applicants identified and solved. Accordingly, Applicants believe that claims 1 and 5-7 are patentable over Kimura, and respectfully solicit the Examiner's allowance of these claims over Kimura.

For these reasons, Applicants believe that Kimura does not anticipate claims 1, 5, and 7, even if Examiner is correct to ignore major portions of the claims for patentability. However, for the reasons given below, Applicants believe that it is improper for the Examiner to refuse to give patentable weight to the extensive portions of the claims cited in paragraph 6 of the Final Office Action.

The Examiner has declined to give any patentable weight to the limitation "wound in an annulus on a mandrel" on the ground that "the method of forming the device is not germane to the issue of patentability of the device itself." Applicant respectfully asserts that they are allowed to defined structure in terms of process limitations. Indeed, "method or process limitations" in claims to devices are commonplace and routinely given patentable weight. Examples include "welded", "folded", "intermixed", ground in place", "etched", interbonded by interfusion", and "press fitted" (the latter found in US 6,247,382 to Umeki et al. issued by David A. Bucci). Applicants note that the limitation "helically wound around the axis" appears in claim 1 of U.S. 5,122,417 to Murakami et al., and the limitation "fiber and epoxy matrix wound into a substantially cylindrical configuration" appears in claim 1 of U.S. 4,370,899 to Swartout, the latter three patents all of record in this application. These

are all "process limitations" in article claims that the PTO issued. Applicants respectfully submit that there is no court in this country that would hold these patents to be invalid because they have process limitations in their article claims. Applicants believe that there are no compelling reason for refusing to accord patentable weight to "wound in an annulus on a mandrel" in claim 1. These same remarks apply to the other claim language to which the Examiner refuses to accord patentable weight.

It should be noted that there are structural limitations inherent in the limitation "wound in an annulus on a mandrel". It implies that the fibers circle the mandrel in a generally helical circumferential direction in which they can offer the greatest strength in the hoop direction, which is important to a structure used as a flywheel rim. Naturally, the winding cannot occur at exactly 90° or the fibers would not be wound on the full length of the mandrel, so there must be some angle. So "wound in an annulus on a mandrel" is a concise and clear description of the structure that anyone skilled in the art would understand instantly.

The Examiner cites MPEP 2113 for legal authority to support the position that process limitations in article claims are not given patentable weight. This section of the MPEP does not support the Examiner's position. Indeed, it specifically states that the structure implied by the process limitations should be considered when assessing the product-by-process claims, especially when the manufacturing process steps would be expected to impart distinctive structural characteristics to the final product. MPEP 2173.05(p) expressly states that:

> A product-by-process claim, which is a product claim that defines the claimed product in terms of the process by which it is made, is proper.

Applicants believe that the structure of the flywheel rim defined in claims 1, 5 and 7 is informed by the limitations cited by the Examiner as "process of forming" limitations that are not given any patentable weight. Together with the specific structural limitations defined in these claims, the limitations that the Examiner considers to be process limitations define a fiber-wound structure having a random distribution of two different types of fibers without the problem of undesirable stacking or radial alignment of same fiber types, as clearly described in the specification.

Specifically, the phrase "wound in an annulus on a mandrel" defines an annular structure having generally circumferentially extending fibers lying at some angle off 90° on the structure that fiber winding produces. Fiber winding is a known process and is

a commonly used expression in patent claims in this technology. For example, the limitation "helically wound around the axis" appears in claim 1 of U.S. 5,122,417 to Murakami et al., and the limitation "fiber and epoxy matrix wound into a substantially cylindrical configuration" appears in claim 1 of U.S. 4,370,899 to Swartout, both of which patents are of record in this application. Allowing use of this expression in some applications and not others would appear to be arbitrary. Applicants cannot fathom why this phrase must be ignored in the claim, particularly in view of the express authorization for this type of claiming in the MPEP.

The Examiner also objects to the following paragraph in claim 1 (and the corresponding language in claim 5):

> said fiber is distributed in said cylindrical fiber-wound structure as bands of tows, each tow having only a single type of fiber, said tows lying in a lay-up pattern that is defined by the correlation between lead rate per mandrel revolution and winding length to produce a random distribution of said first fiber type amongst said second fiber type macroscopically

The phrase "distributed in said cylindrical fiber-wound structure as bands of tows" might be considered to be a process limitation, but there can be no doubt that it defines a structure having generally circumferentially extending fibers, with the fibers in each layer lying parallel to each other as they do when wound as a band of tows. It is a simple and clear definition of structure, and is much more simple and clear than any attempt to describe the structure without reference to the winding process.

The phrase "each tow having only a single type of fiber" is not a process limitation, so "bands of tows, each tow having only a single type of fiber" should not be objectionable in any way.

The phrase "said tows lying in a lay-up pattern that is defined by the correlation between lead rate per mandrel revolution and winding length to produce a random distribution of said first fiber type amongst said second fiber type macroscopically" refer to the relation of the lead rate to the winding length. It is structural definition of the lay-up pattern. The lead rate is a structural definition, namely, the longitudinal distance between adjacent turns of a band of fiber, measured center-to-center, on the mandrel. The winding length is also a structural definition, namely, the traverse distance of fiber band center line between one end of the mandrel and the other end.

The phrase "to produce a random distribution of said first fiber type amongst said second fiber type macroscopically" is a structural definition of the fiber distribution resulting from the relation of winding length to lead rate.

Applicants believe that technical objections such as the refusal to give patentable weight to portions of a claim that is otherwise novel and unobvious, just because they do not conform to a convention pattern, should be used only if there is a real question about the meaning of the claim, and there is no such problem with these claims. There can be no doubt that Applicants have invented a novel and unobvious solution to a problem that hitherto had not been recognized, and Applicants believe that they are entitled to a patent for this invention, even though (or especially because) the claim contains process limitations which help explain the subject matter that Applicants regard as their invention.

C. Claim 6 was rejected under 35 USC 103 as unpatentable over Kimure. Kimura does not disclose the subject matter defined in claim 5, that will ensure that its fibers will be distributed randomly amongst each other, or carbon fiber is distributed amongst the other fiber in a cross hatch pattern macroscopically, and not become aligned radially in the undesirable condition identified and solved by Applicants. Therefore, claim 6, dependent on claim 5, is patentable for that reason. In addition, claim 6 specifies the following relationship between the winding length and the lead rate:

$W_L=(N + B/A)\cdot L_R$

$W_L + L_R < L_m$

N : Maximum integer obtained when W_L is divided by L_R

A : integer larger than B

B : integer smaller than A

B/A \ 1, 1/2, 1/3, 1/4

W_L : Winding Length (inch)

L_R : Lead Rate (inch)

L_m : Distance between inner faces of two mandrel flanges (inch)

$m\cdot L_R = n\cdot Sp$

m : integer □2

n : integer□2

Sp : fiber space amongst other fiber (inch)

The Examiner asserts that these limitations in claim 6 would have been obvious to a person of ordinary skill in the art because it would have been obvious to one of ordinary skill in the art to "optimize the strength of the flywheel".

Of course, the general aim of "optimizing the strength of the flywheel" will always be a desirable objective in any flywheel design effort, but there is nothing in the prior art that would have made it obvious to one of ordinary skill in the art that the relationship defined in claim 6 would have "optimized the strength of the flywheel". The invention was made to solve a problem that hitherto had not been recognized. The prior art of record does not show any recognition of the problem discovered by Applicants, so there would have been no inducement to do the "routine experimentation" that the Examiner refers to, even if "routine experimentation" would have resulted in making the invention, which Applicants deny. But what is the "routine experimentation" that the Examiner thinks would have been obvious? "Routine experimentation" has an aim, a purpose; it is not just random fiddling. Those skilled in the art would not wind flywheel rims, fiddling with the lead rate and winding length, in the hope that somehow it would unexpectedly result in "optimizing the strength of the flywheel" without some idea how that would result in the improved strength? There would need to be some expectation that the experiment would address some recognized problem or weakness in the flywheel, and that something would come of the effort. Without some notion that a specific element or parameter of the flywheel that was defective or weak would be improved by the experiment, it would never be conducted. It is not correct to say that those skilled in the art make random experiments with no notion of a specific expected result. That is not the way experimentation is done by those of ordinary skill in the art. There are too many parameters that would be candidates to change randomly to approach product design in that manner; it would take forever to cover all the possible things that could be changed.

The Examiner explains how the person of ordinary skill in the art would discover the relationship defined in claim 6 as follows: "The optimum winding length can be changed through routine experimentation by changing the lead rate. A worker with a general (ordinary?) skill in the art is able to achieve these results." Applicants respectfully submit that changing the lead rate has nothing to do with finding the "optimum winding length". In fact, the invention has nothing to do with "optimizing the winding length." The winding length W_L is simply the traverse distance of fiber band center line between one end of the mandrel and the other end during winding. It does

not need to be "optimized". It is basically merely the length of the mandrel. Changing the lead rate does not change the winding length. The invention is to select the lead rate in relation to the winding length to ensure that the fiber tows in the fiber band do not stack radially in successive layers in undesirable ways, as explained in detail in the specification. There is nothing whatsoever in the prior art of record that would suggest that this could be a problem or what form a solution might take.

Kimura is not analgous prior art because his claimed article is structural element such as a column or beam that must have good bending strength and bending modulus, two features that are insignificant in the design of flywheels. However, even if Kimura were considered analogous art, his structure does not have a random distribution of fiber types amongst each other, wound in a band for fiber tows. His fibers are all wound in layers of carbon fiber except for a intervening layers of glass fibers inserted for cushioning of the carbon fibers. They are not randomly distributed amongst each other, but instead are specifically and intentionally laid down in layers of one or the other fiber type, not in a fiber band having a ratio of tows that is constant in each layer of any single zone, with each fiber layer having a mixture of carbon fiber tows and glass fiber tows as claimed in claim 7.

Thus, Applicant believes that the claims now pending in this application are patentable over the cited prior art and are allowable in their present form. Applicant respectfully requests that the Examiner's final rejection be reversed and that this application be remanded to the Examiner for allowance.

Respectfully submitted,

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9) Appendix

Claim 1 A hybrid composite flywheel rim comprising: a cylindrical fiber-wound structure having at least two different types of fibers, including a first fiber type and a second fiber type, impregnated with a thermosetting resin such as epoxy resin and wound in an annulus on a mandrel, said two different fibers having different elastic moduli;

said fiber is distributed in said cylindrical fiber-wound structure as bands of tows, each tow having only a single type of fiber, said tows lying in a lay-up pattern that is defined by the correlation between lead rate per mandrel revolution and winding length to produce a random distribution of said first fiber type amongst said second fiber type macroscopically.

Claims 2-4 (canceled)

Claim 5 A hybrid composite flywheel rim, comprising:

fibers having different elastic moduli, said fibers including carbon fiber, and at least one other fiber including glass fiber, said fibers fixed in a matrix of thermosetting resin such as epoxy resin;

said fiber is distributed in said cylindrical fiber-wound structure as bands of tows, each tow having only a single type of fiber, and said carbon fiber is distributed amongst the other fiber in a cross hatch pattern macroscopically.

6. A hybrid composite flywheel rim as defined claim 5, wherein:

the following equation is satisfied:

$W_L=(N + B/A)\cdot L_R$

$W_L + L_R < L_m$

N : Maximum integer obtained when W_L is divided by L_R

A : integer larger than B

B : integer smaller than A

B/A \ 1, 1/2, 1/3, 1/4

W_L : Winding Length (inch)

L_R : Lead Rate (inch)

L_m : Distance between inner faces of two mandrel flanges (inch)

$m \cdot L_R = n \cdot Sp$

m : integer □2

n : integer□2

Sp : fiber space amongst other fiber (inch)

7. A composite flywheel rim, comprising:

an annular structure having a plurality of zones, each with multiple fiber layers in a resin matrix, each said fiber layer having a mixture of carbon fiber tows and glass fiber tows wound in a fiber band with a predetermined lead rate into said annular structure, said band having a ratio of tows that is constant in each layer of any single zone, and said ratio incrementally increases zone-by-zone radially toward outside zones of said rim;

wherein said predetermined lead rate, in correlation with the winding length, ensures that said carbon fiber tows lie in a macroscopically uniform distribution in each zone.